



Sampling techniques and structure of the malacofauna associated to the rhizome zone in *Posidonia oceanica* (L.) Delile

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KEY WORDS: *Posidonia oceanica*, sampling techniques, abundance distribution models, nomocenosis, Mediterranean Sea.

ABSTRACT The introduction of methodological variants in sampling through air pump in the rhizome layer of *Posidonia oceanica* beds allows to stress a "filter effect" due to the presence of the leaves during the pumping. Inside the same *Posidonia* bed, on areas of the same surface, the sample areas in which all leaves are preventively cut off to uncover the rhizome layer show an increase of information with respect to areas with leaves. The comparative analysis of abundance distribution models shows that similar results are obtained by increasing the sample area.

RIASSUNTO Tecniche di campionamento e struttura della malacofauna associata alla zona dei rizomi di *Posidonia oceanica*. L'introduzione di varianti metodologiche nel campionamento con sorsobona dello strato dei rizomi di una prateria di *Posidonia oceanica* (L.) Delile ha consentito di evidenziare un notevole "effetto filtro" operato dalle foglie all'azione di aspirazione. Considerando aree campione di stessa superficie all'interno di un medesimo posidonieto, aree preventivamente defoliate rendono disponibile una maggiore quantità di informazione rispetto ad aree non defoliate. L'analisi comparativa dei modelli di distribuzione di abbondanza, relativi ai due tipi di aree, mostra che i risultati sono analoghi a quelli ottenibili aumentando la superficie campione.

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INTRODUCTION

The analysis of structurally and ecologically complex environments, as *Posidonia oceanica* beds, needs setting up of suitable sampling techniques in order to obtain both the maximum information through the minimum effort and the preservation of the univocal relation between the surveyed element and its relative information.

Considering the elements of a bed (the rhizome stratum, the foliar stratum, the "mattes"), the relative information seems to point out the presence of different biocenosis associated to the different microhabitats (OTT & MAURER, 1977; IDATO *et al.*, 1983; RUSSO *et al.*, 1983; RUSSO *et al.*, 1984a; RUSSO *et al.*, 1984b; RUSSO *et al.*, 1984c; BIANCHI *et al.*, 1989), for which different sampling techniques have been set up. The most utilized techniques are direct ones as they foresee an active and aimed action by the scuba-diver operator. They can be summarized as:

- sampling through an air-pump, used in the rhizome layer and in the "mattes" (CORSELLI, 1980; DE METRIO *et al.* 1978; DE METRIO *et al.*, 1980).
- sampling through a hand-net, used in the leaf-layer (LEDOYER, 1962; LEDOYER, 1966; RUSSO *et al.*, 1985; RUSSO *et al.*, 1986; RUSSO & VINCI, 1991)
- removal of a whole clod of weed (BIANCHI *et al.*, 1989).

Each technique has some bias affecting the information about the population, because of the *Posidonia* weed structure with leaves covering the underlying rhizome. The most common bias is the veil-effect of the leaves and a mixing of material due to the hydrodynamic disturbance produced by the air-pump. This leads the animals falling according to the well known

"falling reflex" (ISSEL, 1912; RUSSO, 1989). Concerning the technique proposed by BIANCHI *et al.* (1989) there is no doubt that it involves a loss of information about the probable vertical distribution of the population but it allows a whole recover of the qualitative and quantitative information.

Because of these reasons and within a program of investigation of the biocenosis associated to the *Posidonia* beds at Isola del Giglio (Grosseto, Italy) we decided to test the most appropriate sampling techniques comparing, inside the same bed, two samples carried out with methodological variants on areas of the same surface.

MATERIALS AND METHODS

The samples have been collected at Campese (Isola del Giglio, Grosseto, Italy), (last week of March 1992, calm sea, cloudy weather) within a *Posidonia* bed growing on "mattes" lying on a detrital substrate 9 m depth. Two 3 m²-areas have been sampled using a PVC air-pump with a 7 cm-diameter opening and with a nylon sampling bag having a 0.5 mm-mesh. The first area (called area A) has been treated as usual: the rhizome layer having been pumped, while the 2nd area (area B) has been netted by 30 strokes in order to remove the leaf population. The net consists of a rectangular frame (40x20 cm) provided with a nylon sampling bag with a 0.5 mm-mesh. 30 more strokes have been carried out outside the investigated area in order to get a representative sample of the leaf population (RUSSO & VINCI, 1991). In the netted area, all the leaves have been cut off by scissors and the uncovered rhizome area has been pumped using the same air quantity (about 150 atm) used for area A.

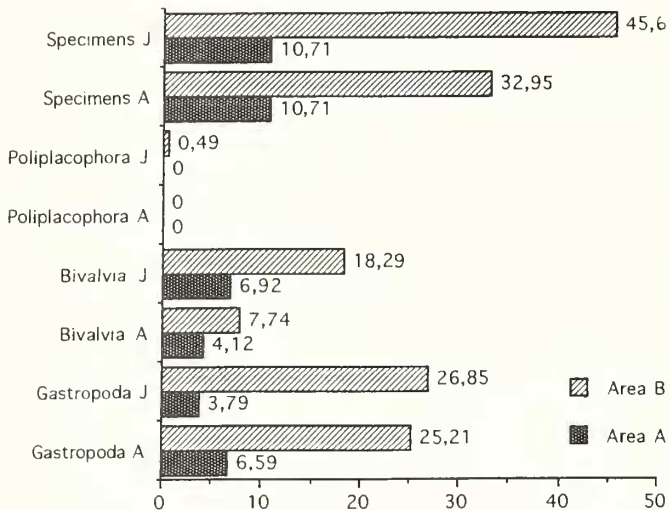


Figure 1. Percentages of adults (A) and juveniles (J) of the different classes.

The sorting has been carried out within few hours in order to an easier identification of the living specimens. The species occurring in all samples with only one individual and the parasitic species were not considered in the numerical analysis (FRESI & GAMBI, 1982). We consider the presence of the parasites related more to their guest than to the specific environment. Quantitative and qualitative analysis has been carried out on the samples considering also the juveniles of each species. We considered as juveniles smaller individuals with uncomplete aperture and peristome.

The structural differentiation degree of population has been evaluated by the Shannon-Weaver's diversity index and the comparison among the values has been carried out by the equitability index (PIELOU, 1966; PIELOU, 1966A; DAGET, 1976). We decided to use, as other authors (BIANCHI *et al.*, 1989) a model of abundance distribution, in particular the log-linear one of Motomura and the log-normal of Preston (DAGET *et al.*, 1972; DAGET, 1976; AMANIEU *et al.*, 1980), in order to test the range and the trend frequency to evaluate the possible analogy and dissonance among the samples. The correspondence degree to the models has been evaluated according to the values of the correlation coefficient, according to the empirical role, determined by INAGAKI (1967) for the Motomura model and extended by AMANIEU *et al.* (1980) for the Preston model, which establishes that the adjustment is bad if $|r| < 0,95$, approximate if $0,95 < |r| < 0,98$, sufficient if $0,98 < |r| < 0,99$ and strict if $|r| > 0,99$.

RESULTS AND DISCUSSION

A total of 59 species with 645 individuals have been collected in two samples (area A

and area B); in the sample coming from the leaves 11 species have been collected (of these *Jujubinus exasperatus* and *Rissoa violacea* are exclusive), with 303 individuals. The results of the biometrical analysis are reported in tab. 1. If we do not consider the species with only one specimen (FRESI & GAMBI, 1982) and the parasites (indicated in tab. 1 with an asterisk), we get a partial sub-sample, area A + area B, of 33 species and 607 individuals. 24 species (72,73%) and 130 individuals (21,42%) have been found in the area A, while 32 species (96,97%) and 477 (78,58%) individuals are present in the area B. Within the samples, the percentages of adults and juveniles of the different classes are shown in Fig. 1. Altogether, area B seems to be clearly richer in every component. The data referred to the juveniles seem to be extremely important, both in the total and among the classes, in particular 80,1% of all the juvenile and 87,6% of young gastropods have been found in the leafless area.

The diversity index, calculated for both samples, are 1,13489 for area A and 1,03058 for area B. According to the equitability index, that is to say according to the relationship between the observed diversity and the maximum diversity, the two samples are structurally different; in particular area A, with value of 0,822 shows a higher differentiation compared to area B having a value of 0,685. In area A the coefficient of correlation $|r|$ is approximate in both models (Motomura's model $|r| = 0,962$; Preston's model $|r| = 0,952$). In the leafless area the correlation is bad for the log-linear model ($|r| = 0,935$) and approximate for the Preston's model ($|r| = 0,950$).

Two are the remarkable aspects: the distribution of the commonest species approximate the normality in both samples (Fig. 2), and the frequency percentages of the species having the same rank are very similar (Fig. 3) except the first rank species. According to AMANIEU *et al.* (1980), in order to save the ecological information of the lengthened populations and don't overestimate the significance of the low frequency species, it is useful to consider the rarest species as only one class. These considerations lead us to group the 9 rarest species of the area B in order to obtain the same rank number (24) in the two samples.

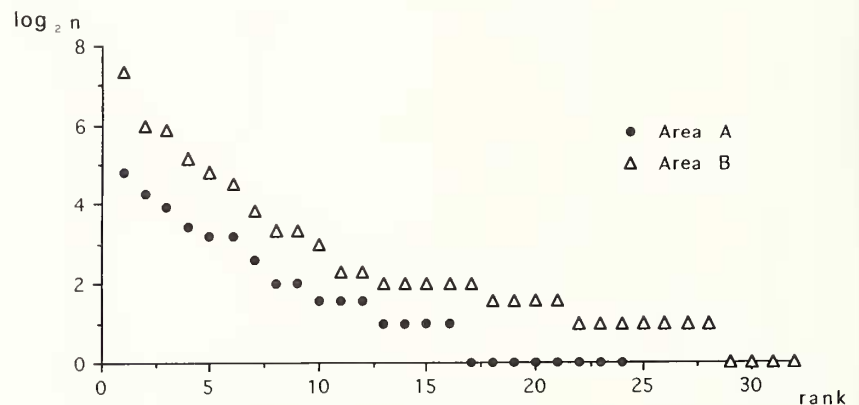


Figure 2. Distribution of the species on a log scale.

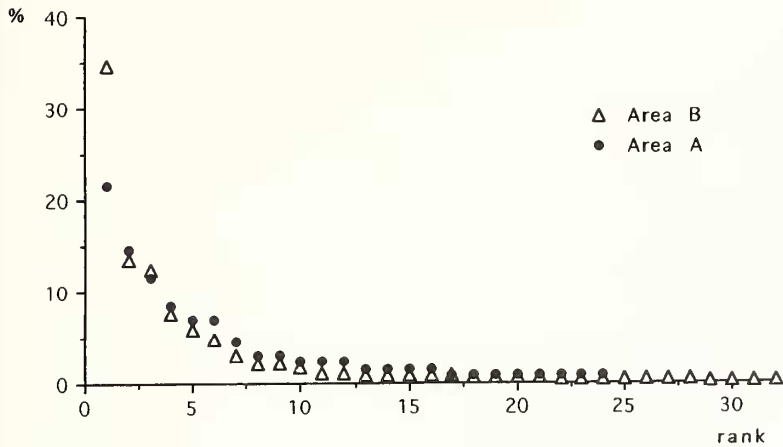


Figure 3. Frequency percentage of the species.

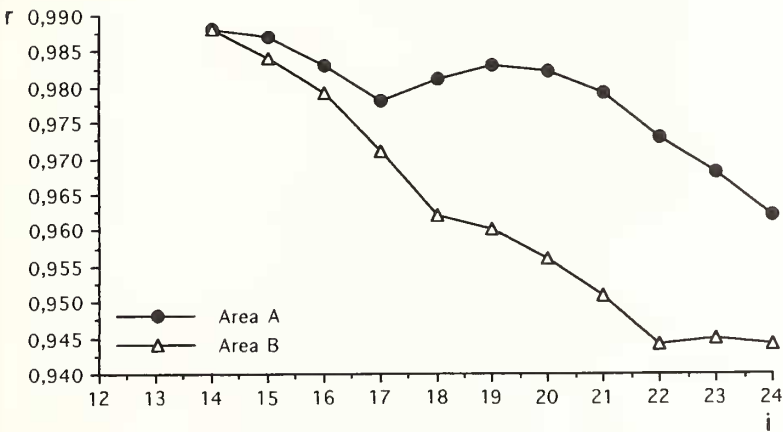


Figure 4. Trends of correlation coefficient $|r|$ related to the number of species (i) according to Motomura's model.

We have been able, in such a way, to compare exactly the $|r|$ values derived from models applied to samples with the same rank number (DAGET, 1976). We have then reduced, step by step, the rank number of each sample by grouping in the single class of rare species those ones having the lowest frequency. Variations in correlation coefficient of the two models are shown in Figs. 4 and 5. Such a data analysis indicates:

- 1) rare species contrast with the trend to normality by lengthening the end distribution of populations having several groups *ex aequo*;
- 2) rare species are chiefly responsible for differentiation of the information about the structure of the sample. Such a difference is going to disappear while the rank number reduces.

We especially have a strong analogy in the information regarding the distribution of the first 13 species plus a cumulate class (14 ranks model). In the area A the cumulate class represents 10,76% individuals of the sample; the percentage of the same class from the area B is very similar, that 9,6%.

In both samples the log-linear model seems the most appropriate to draw the distribution of the 14 frequencies (Fig. 6). The linear correlation coefficient reaches the sufficient level both in area A ($|r|=0,988$ (corresponding to a Motomura constant $m=0,824$) and in area B ($|r|=0,987$; $m=0,766$). Correlations are appropriate (i.e. lower) (area A $|r|=0,981$; area B $|r|=0,985$) according to the model of Preston if we consider the same rank number.

As regards the leaf population, this is made trivial by the rather infesting presence of *Bittium latreilli* (chiefly in adult stage) representing 81,13% of the whole individuals found. Such a massive presence could explain, to some extent, the very high relative frequency of this species in the sample from the area B where a greater handling of the leaf stratum was surely carried out. Another characteristic of the leaf population is the absence of bivalves.

CONCLUSIONS

In both areas the capture-collecting ranks are quantitatively and qualitatively significantly different. The cutting of leaves seems to induce a widening of the sampling area. As a consequence we observe an increase of information both about the increase of frequencies of the commonest species and juveniles and about the finding of new species not previously collected in area A. The apparent widening effect in area B is also evident if the abundance distribution models of the most common species are analyzed (14 ranks-model). As a matter of fact the relative relationships among these species distribution look totally comparable between the two samples; this similarity is evident above all by the m values. This constant is equal to the antilogarithm of the angular coefficient; the degree of the geometrical increase which exists between the two species inside the distribution can be valued by it. Moreover it allows a balanced valuation of the structure of the sample because its value does not change when the structural level, sufficient to define a "nomocenosis", is reached; this means a population whose frequency distribution relates sufficiently to the models of Motomura or Preston (DAGET, 1972).

A nomocenosis is basically characterized by an m value and by the number of species, independently from their taxonomy. Moreover, once this has been defined, it becomes independent from the sample size. Practically the straight line laying under it moves parallel from itself maintaining the same angular coefficient and, therefore, the same m value too. This aspect seems to come out from the considered distributions: the first 14 ranks (see Fig. 6), in the area A and in the area B, are occupied by species with absolute frequency very different (higher in B than in A), but this does not seem to highly affect the relative distribution of the frequencies (same degree of correlation, same constant of Motomura). We can after all consider both samples as representatives of the same nomocenosis; we can consider suffi-

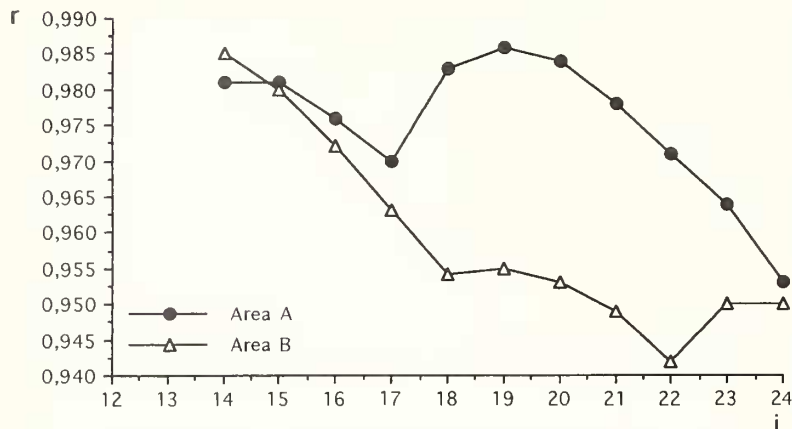


Figure 5. Trends of correlation coefficient $|r|$ related to the number of species (i) according to Preston's model.

cient the information hold in the area A as far as regards the sampling and the definition of a nomocenosis, while in the area B the cutting of leaves gives us a better qualitative but not quantitative information. In fact the relative relationships among the frequencies of the most common species, in B and in A, is constant. The juveniles of both bivalves and gastropods represent the main difference in the information surplus. The high number of young specimens collected in area B seems to indicate a clear preference as regards the microhabitat of the rhizome stratum. This clearly appears if we analyze the distribution of the most abundant species (*Bittium latreillii*). This can mean that this species, and more in general most of the gastropods, use such microhabitat as a nursery and move successively, as adults, preferably towards the leaf stratum. A bigger quantity of epiphytic nutrients and a higher hydrodynamic stability can determine this vertical seriation of the different developmental stages. As regards the bivalves, their absence from the foliar stratum is probably due to the higher hydrodynamicism with respect to the rhizome stratum, which appears a more suitable substratum for the bivalve habitus.

The last aspect to be considered is the probable recruitment, on the rhizomes of species coming from foliar stratum. The analysis of the three samples (two air-pump samples and the net-sample) allows to partly minimize the effect of the hydrodynamic disturbance caused by the air-pump on the area with leaves. As a matter of fact we utilize the adults of *B. latreilli* as markers of this effect, considering the very high number of specimens on the leaves, we can stress how in the area A we collected few specimens. On the contrary, a quite high number of adults of *B. latreilli* in the area B, which slightly contributes to the increase of m value, seems to suggest that not the whole population living on leaves has been collected by the hand-net and the adjustment-rearrangement of these, during the leaf-cut, may have determined the falling of adults on the rhizome. Probably a second collection by the hand-net after few hours from the first one, on the area when the cutting leaves will be executed, could contribute to minimize this effect.

We can conclude that the variants introduced in the sampling

methodology are satisfactory concerning the amount of information collected. The variant introduced in sampling area B doesn't appear as an artefact able to affect the information about the population of the rhizome stratum collected in the area with leaves. Such an information is conversely preserved and enhanced leading to put in evidence a "filter effect" due to the presence of the leaves during the pumping which would not be suspected.

The last remark is about the presence of living specimens of the Fissurellidae *Emarginula pustula* Thiele in Kuester, 1913, that confirms its presence inside the biocenosis of *Posidonia oceanica*, as it was already pointed out in other samples collected at the Isola del Giglio (BONFITTO & SABELLI, 1992).

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SPECIES	Area A			Area B			Net-sample		
	ad.	juv.	Tot.	ad.	juv.	Tot.	ad.	juv.	Tot.
1 Callochiton septemvalvis euplaeae	0	0	0	0	3	3	0	0	0
2 Smaragdia viridis	1	0	1	3	0	3	0	0	0
3 Emarginula pustula	1	0	1	2	0	2	0	0	0
4 Clanculus jusseui*	0	0	0	1	0	1	0	0	0
5 Jujubinus exasperatus*	0	0	0	0	0	0	4	0	4
6 Jujubinus gravinae*	0	0	0	1	0	1	0	0	0
7 Jujubinus striatus	5	4	9	10	0	10	16	0	16
8 Tricolia pullus pullus	1	0	1	6	4	10	0	0	0
9 Tricolia tenuis	1	0	1	1	0	1	1	0	1
10 Cerithium aluclaster*	0	0	0	1	0	1	0	0	0
11 Cerithium vulgatum	0	0	0	1	1	2	0	0	0
12 Bittium jadertinum	0	6	6	0	28	28	0	2	2
13 Bittium latreillii	4	11	15	53	112	165	231	14	245
14 Rissoa auriscalpium	0	1	1	0	0	0	1	0	1
15 Rissoa decorata	3	0	3	4	0	4	9	0	9
16 Rissoa ventricosa	2	0	2	2	0	2	11	0	11
17 Rissoa violacea*	0	0	0	0	0	0	4	0	4
18 Alvania cimex	2	0	2	3	0	3	0	0	0
19 Alvania discors	4	0	4	22	1	23	8	0	8
20 Alvania geryonia	1	0	1	1	0	1	0	0	0
21 Alvania lineata	1	0	1	1	0	1	1	0	1
22 Alvania pagodula	0	0	0	4	0	4	0	0	0
23 Pusillina radiata	2	0	2	1	0	1	1	0	1
24 Rissoina bruguieri	0	0	0	0	2	2	0	0	0
25 Natica dyllwynii	0	0	0	1	1	2	0	0	0
26 Triphoridae indet.*	1	0	1	0	0	0	0	0	0
27 Marshallora adversa*	0	0	0	7	0	7	0	0	0
28 Cerithiopsis sp.*	2	0	2	0	0	0	0	0	0
29 Epitonium commune*	0	0	0	0	1	1	0	0	0
30 Melanella polita*	1	0	1	2	0	2	0	0	0
31 Desmoureaux scalaroides*	1	0	1	0	0	0	0	0	0
32 Buccinum corneum*	1	0	1	0	0	0	0	0	0
33 Fusinus pulchellus*	1	0	1	0	0	0	0	0	0
34 Nassarius incrassatus	9	2	11	22	14	36	0	0	0
35 Coumbella rustica*	0	0	0	1	0	1	0	0	0
36 Vexillum tricolor*	0	0	0	1	0	1	0	0	0
37 Gibberula miliaria*	0	0	0	0	1	1	0	0	0
38 Gibberula philippii*	1	0	1	0	0	0	0	0	0
39 Granulina marginata	0	0	0	8	0	8	0	0	0
40 Fasciolaria lignaria	0	0	0	2	0	2	0	0	0
41 Mangelia stossiciana*	0	1	1	0	0	0	0	0	0
42 Mangelia vauquelini	0	0	0	2	0	2	0	0	0
43 Raphitoma linearis	2	0	2	4	0	4	0	0	0
44 Eulimella sp.*	0	0	0	0	1	1	0	0	0
45 Odostomia acuta*	0	0	0	0	1	1	0	0	0
46 Odostomia conoidea*	3	1	4	0	0	0	0	0	0
47 Turbonilla lactea*	0	0	0	0	1	1	0	0	0
48 Turbonilla striatula*	0	0	0	1	0	1	0	0	0
49 Arca noae	0	1	1	0	5	5	0	0	0
50 Barbathia barbata*	1	0	1	0	0	0	0	0	0
51 Striarca lactea	15	13	28	16	48	64	0	0	0
52 Gregariella petagnaie	0	4	4	0	4	4	0	0	0
53 Modiolula phaseolina*	0	0	0	0	1	1	0	0	0
54 Ctena decussata	0	0	0	1	3	4	0	0	0
55 Chama gryphoides*	0	0	0	0	1	1	0	0	0
56 Neolepton sulcatulum*	0	0	0	0	1	1	0	0	0
57 Glans trapezia	8	11	19	23	36	59	0	0	0
58 Parvicardium ovale*	1	0	1	0	0	0	0	0	0
59 Venus verrucosa	1	8	9	1	13	14	0	0	0
60 Gouldia minima	1	2	3	5	0	5	0	0	0
61 Hiattella arctica	1	2	3	2	1	3	0	0	0

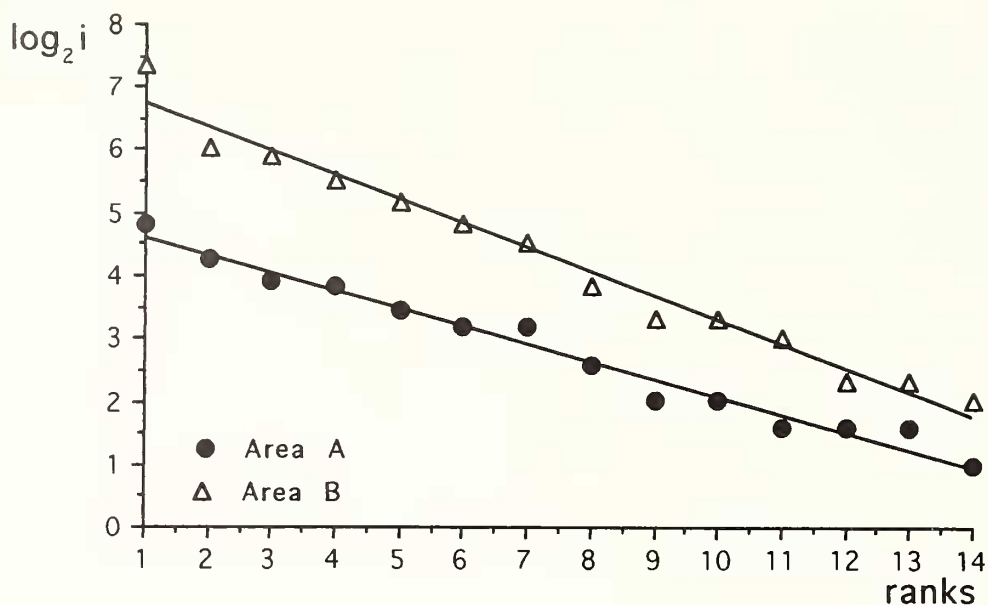


Figure 6. Log-linear models of the first 14 frequencies at two areas (13 ranks + cumulate class).

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